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(54) **ELECTRICALLY POWERED HAND-HELD SCREW DRIVER**

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B25B 23/14 (2006.01)
B25B 23/157 (2006.01)

(52) **U.S. Cl.** **81/429**; 81/467; 81/473

(58) **Field of Classification Search** 81/429, 81/467, 473–476; 173/2, 13, 216, 178; 192/34
See application file for complete search history.

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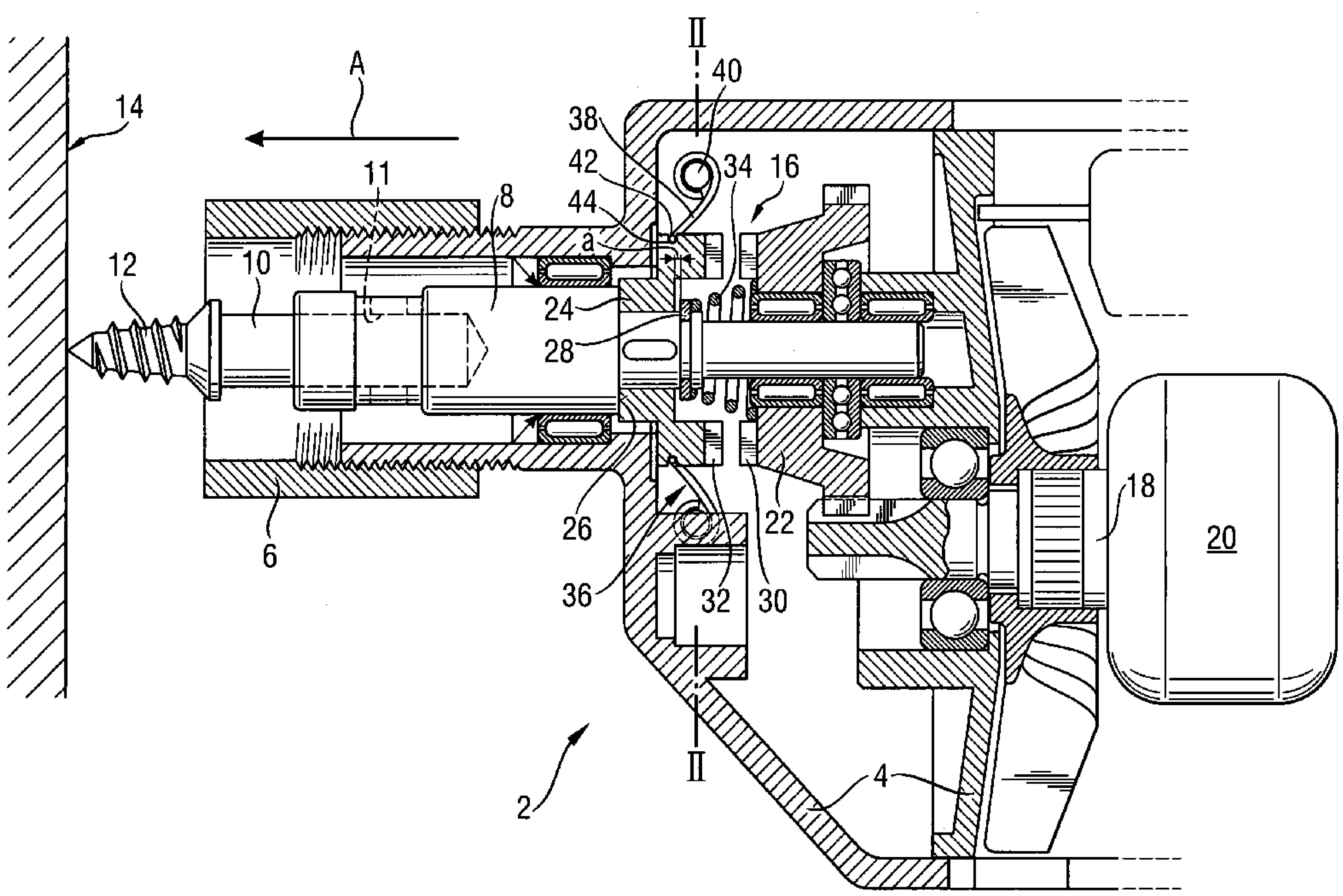
(57) **ABSTRACT**

An electrically powered, hand-held screw driver (**2**) has a housing (**4**), a depth stop (**6**) arranged on this housing (**4**), a drive motor (**20**), an axially displaceable tool spindle (**8**) operatively coupled with a tool holder (**11**), and a torque coupling (**16**) arranged between the drive motor (**20**) and tool spindle (**8**) and which has a motor-side coupling part (**22**) and a tool-side coupling part (**24**) connected to the tool spindle (**8**) so as to be fixed with respect to rotation relative to it. The two coupling parts (**22**, **24**) can be made to engage with one another and the tool spindle (**8**) is biased away from the motor-side coupling part (**22**) by means of a coupling spring (**34**). The tool-side coupling part (**24**) has axial movement play (a) relative to the tool spindle (**8**) and is mechanically coupled with a movement transmitter that is separate from the coupling spring (**34**).

6 Claims, 3 Drawing Sheets



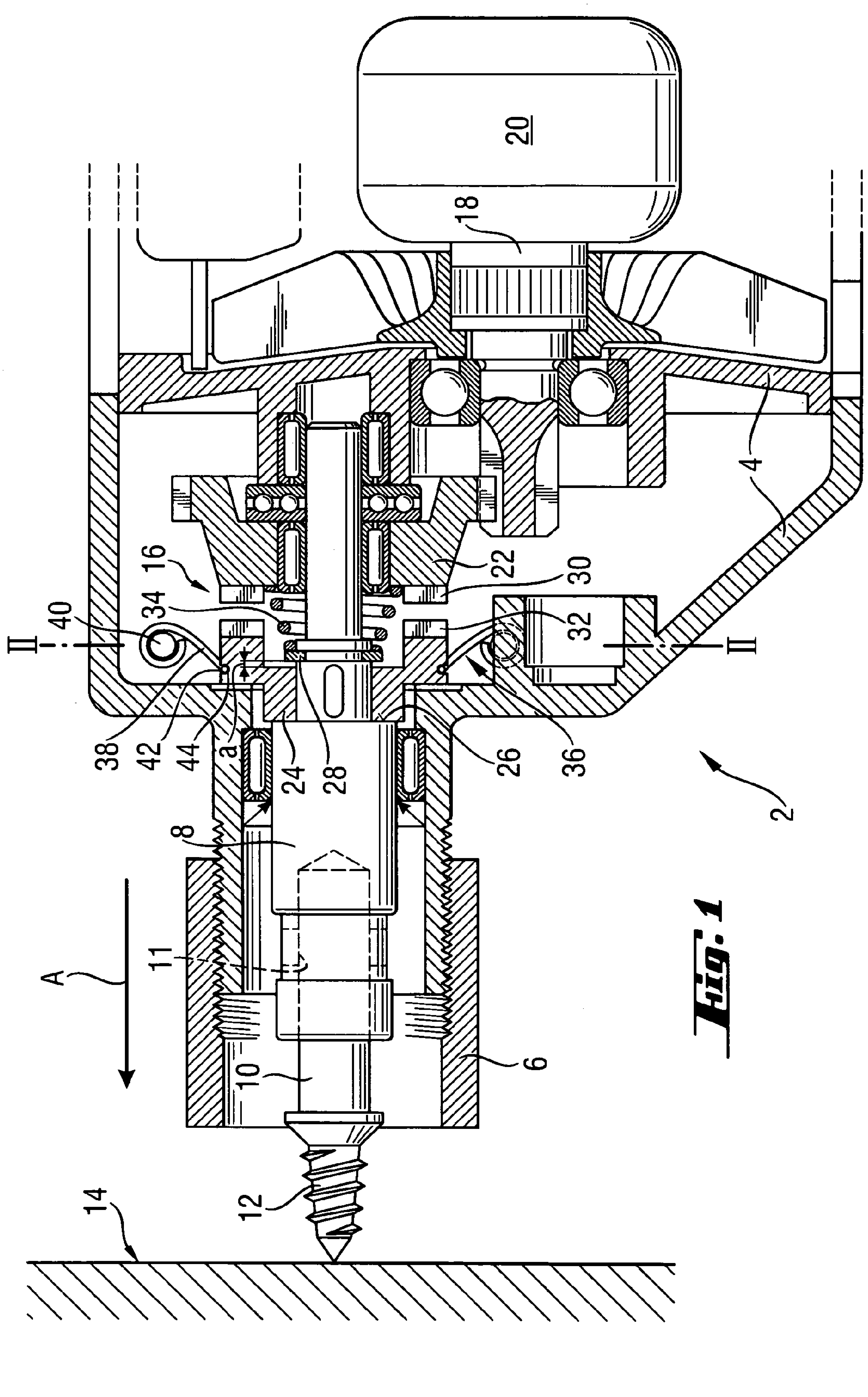


Fig. 1

Fig. 2

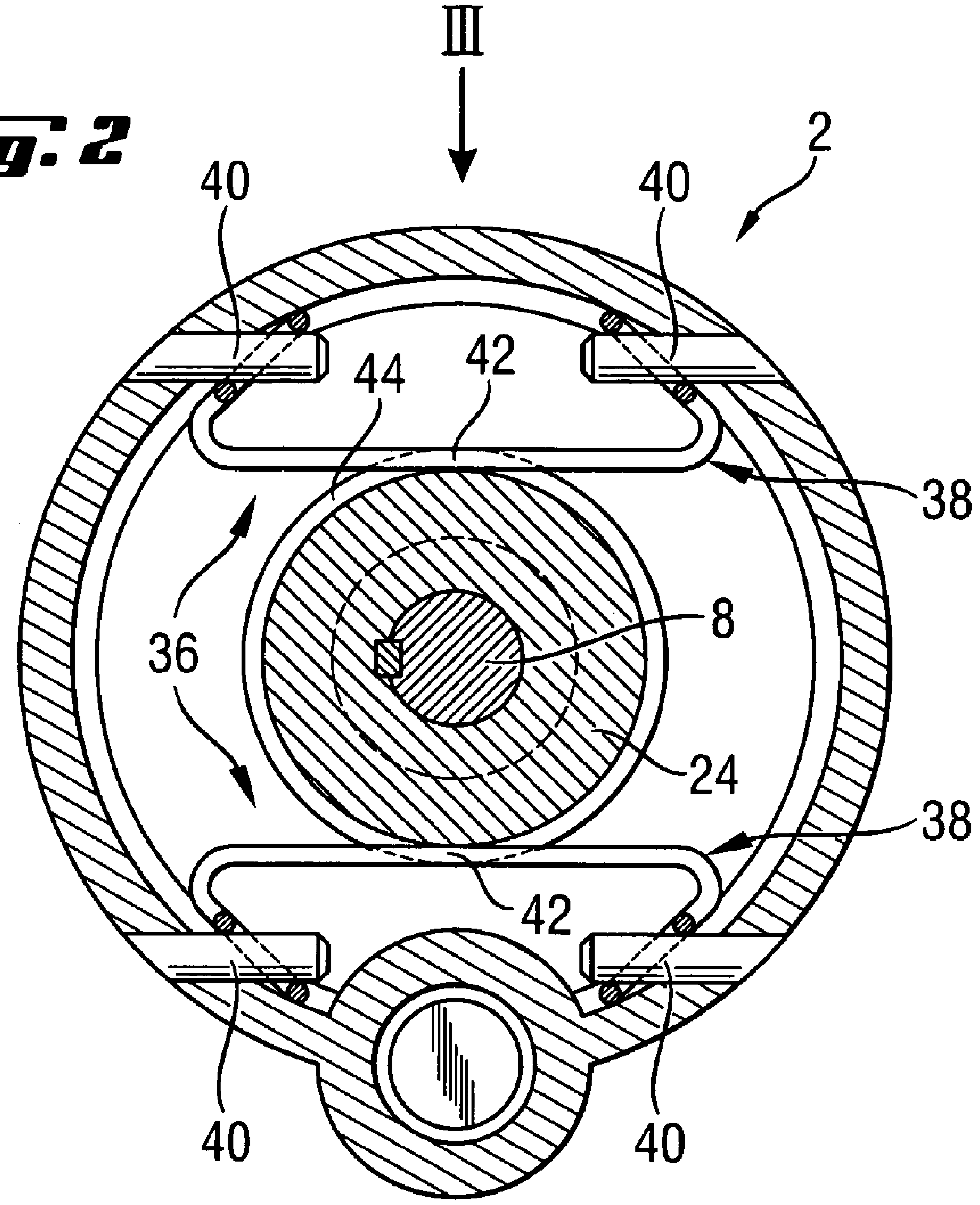


Fig. 3

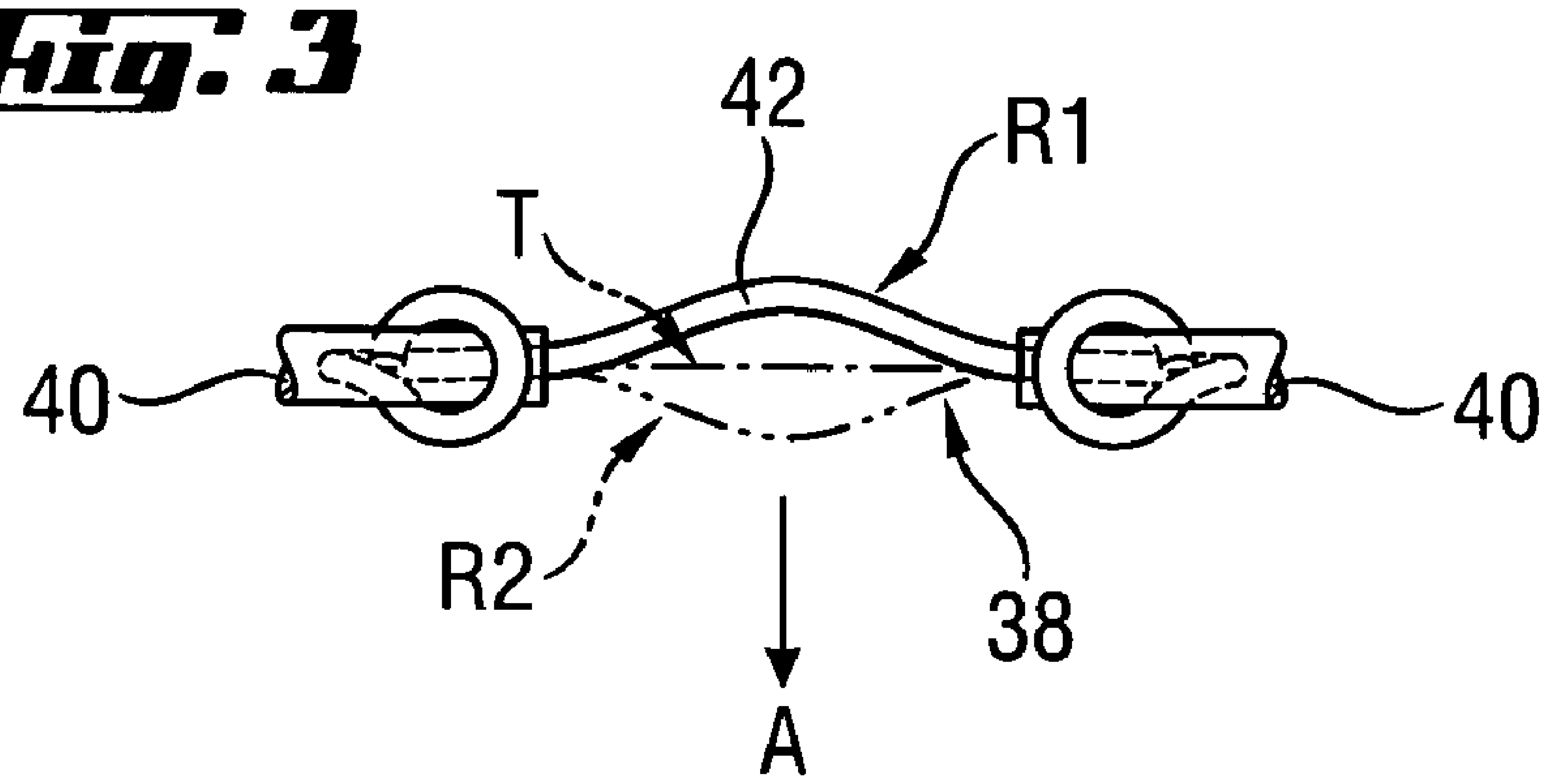


Fig. 4

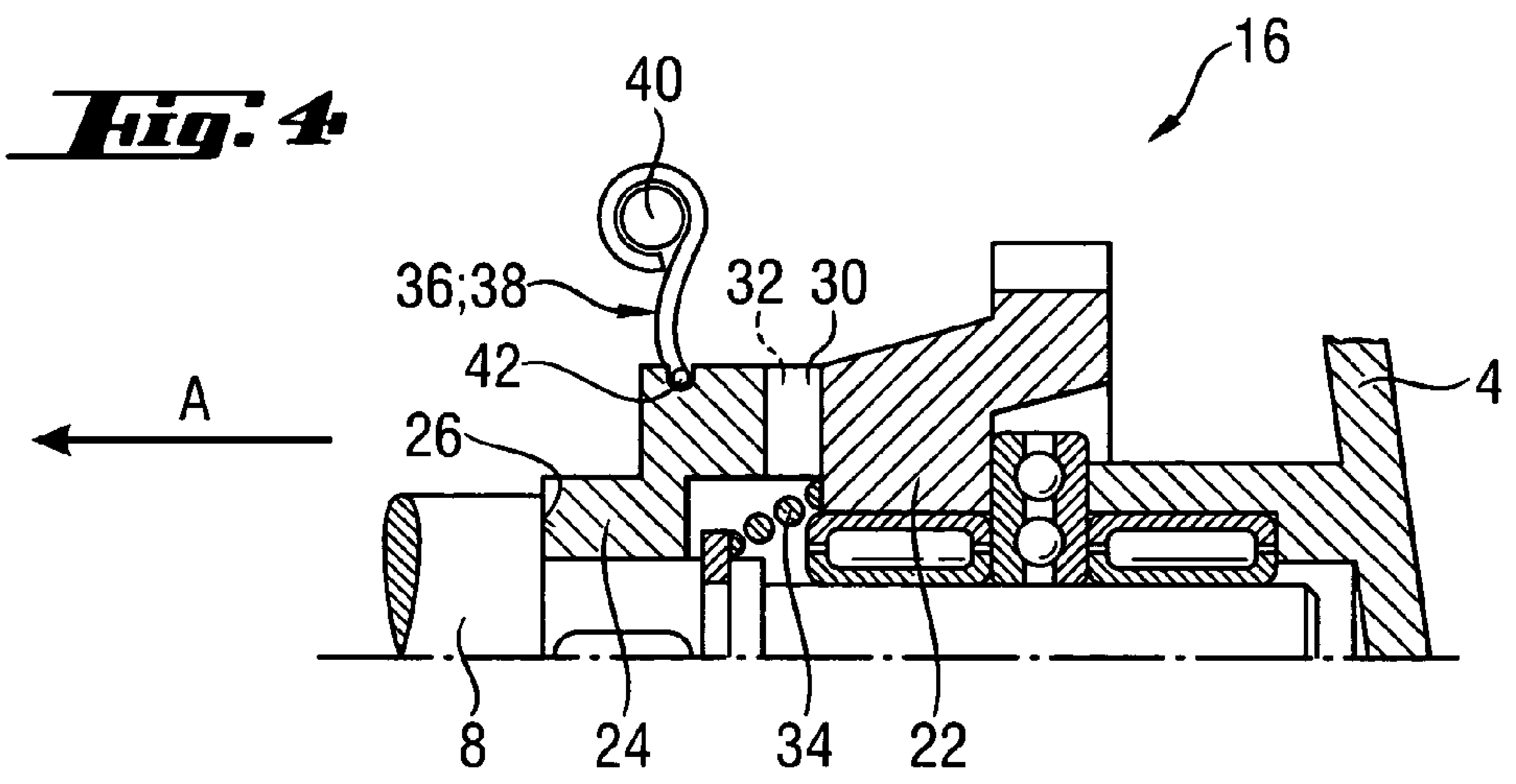


Fig. 5

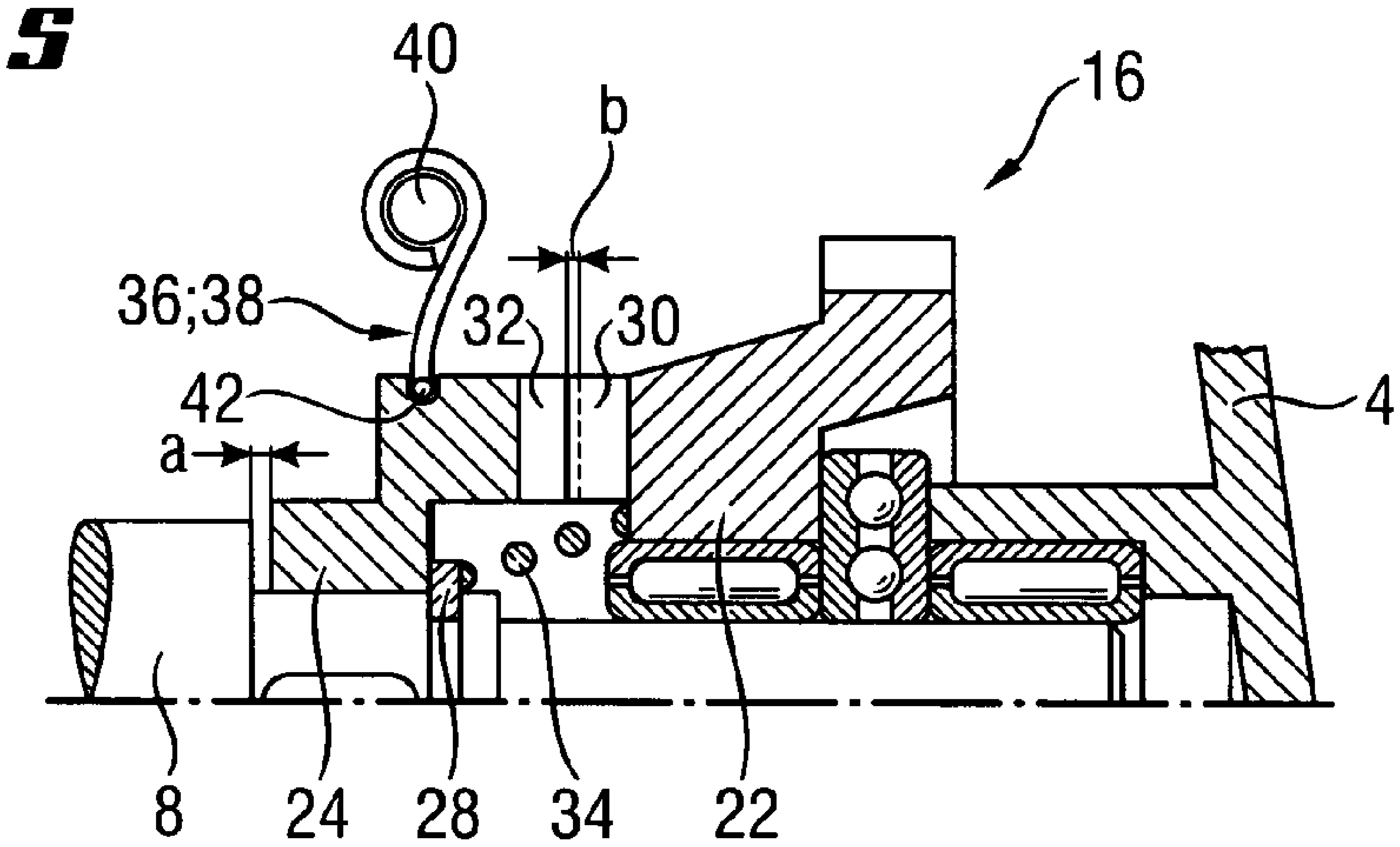
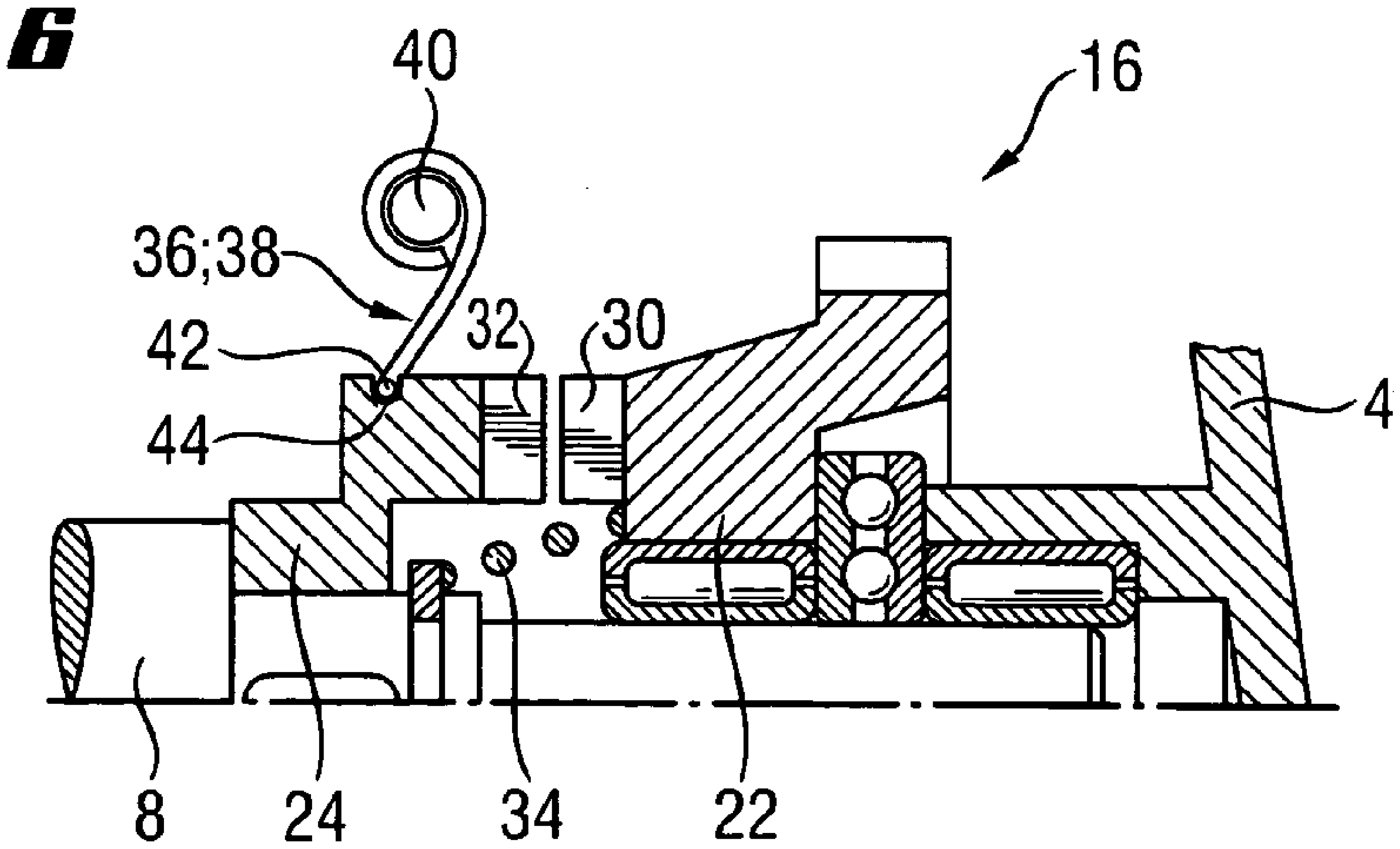


Fig. 6



ELECTRICALLY POWERED HAND-HELD SCREW DRIVER

BACKGROUND OF THE INVENTION

The invention is directed to an electrically powered, hand-held screw driver with a housing, a depth stop arranged at the housing, a drive motor, an axially displaceable tool spindle operatively coupled with a tool holder, and a torque coupling, in the form of a claw coupling, which is arranged between the drive motor and tool spindle and has a coupling part on the motor side and a coupling part on the tool side connected with the tool spindle and fixed with respect to rotation relative to the spindle. The two coupling parts can engage with one another and the tool spindle is pretensioned or biased away from the motor-side coupling part by means of a coupling spring.

Hand-held screw drivers of the type mentioned above have the advantage that a certain screw-in depth for a fastener to be placed, for example, a self-cutting screw, can be adjusted by means of the depth stop. As soon as the depth stop contacts a surface into which the fastener is screwed, the two parts of the torque coupling are separated and the screwing-in process is halted.

DE 198 45 024 discloses a hand-held screw driver in which the torque coupling is formed by a claw coupling with engagement cams. The tool-side coupling part of the claw coupling is secured to the tool spindle in a positive engagement in axial direction. In this hand-held screw driver, as soon as the depth stop strikes the surface to be fastened during a screwing in process, the coupling part on the tool side, together with the axially displaceable tool spindle, is moved farther in the screwing-in direction relative to the housing by means of spring force. During this relative movement with respect to the housing, the tool-side coupling part is moved away from the motor-side coupling part until the two coupling parts disengage. The screwing-in process is stopped at this point.

This known procedure is disadvantageous because the motion of the tool spindle is carried out by means of the spring element and the separation of the two coupling parts is therefore carried out relatively slowly. In this way, the two coupling parts are moved together over a certain period of time in the manner of two ratchet elements, wherein the engagement cams are rotated relative to one another and accordingly strike one another repeatedly. This results in unpleasant noise and a high degree of wear on the coupling parts.

SUMMARY OF THE INVENTION

It is the object of the present invention to avoid the aforementioned disadvantages in a hand-held screw driver with torque coupling and to ensure greater user comfort and a longer operating life.

This object is met, according to the invention, in that the tool-side coupling part has axial movement play relative to the tool spindle and is mechanically coupled with a movement transmitter which is separate from the coupling spring.

In this way, it is possible to move the tool-side coupling part additionally within the limits of the axial movement play independent from the tool spindle. For this purpose, the movement transmitter can be designed in such a way that a faster separation of the torque coupling is achieved. On the one hand, this reduces the noise generated during separation, which increases user comfort, and on the other hand prolongs the life of the torque coupling and of the hand-held screw driver overall.

In a particularly preferred embodiment form, the movement transmitter is formed by a jump device or over-center mechanism which automatically jumps to a second rest position when the dead center position of a first rest position is exceeded and automatically jumps to the first rest position when the dead center position of the second rest position is exceeded. The use of the over-center mechanism makes it possible for the tool-side coupling part to jump back and forth between a first position and a second position depending on the position of the tool spindle relative to the housing and within the limits of the axial play on the tool spindle. By over-center mechanism is meant a device which stores a kinetic energy in a stable rest position and which automatically releases the kinetic energy and executes a sudden movement into another rest position when brought into a releasing position. Therefore, it is possible to make use of the sudden movement of the over-center mechanism for a fast separation of the coupling parts, so that the generation of noise can be sharply reduced. Until the depth stop comes into contact with the surface to be fastened during the screwing-in process, the motor-side coupling part is biased against the latter by the over-center mechanism in a rest position in which it is pressed against the motor-side coupling part. This ensures a reliable engagement of the coupling parts until the depth stop makes contact.

The tool-side coupling part is advantageously still engaged with the motor-side coupling part in the dead center position of the over-center mechanism. In this way, the tool-side coupling part is displaced by the over-center mechanism especially quickly over the relative position with respect to the motor-side coupling part in which the engagement means and counter-engagement means contact against one another. In addition, the movement potential of the over-center mechanism is made use of in this way for a relatively large distance between the coupling parts, which ensures a clear and reliable separation of the two coupling parts.

The over-center mechanism preferably has at least one bistable C-shaped spring element whose ends are completely fixed relative to the housing. In this way, a reliably working over-center mechanism is achieved in a simple manner.

The spring element is advantageously formed from a wire so that the over-center mechanism can be produced at low cost.

Further, a securing ring is advantageously fixedly clamped to the tool spindle and forms a stop for the tool-side coupling part in the direction of the motor-side coupling part and the spring element contacts this securing ring. In this way, the movement play of the tool-side coupling part can be adjusted especially easily. In addition, production costs can be kept low by the twofold bearing function of the securing ring.

BRIEF DESCRIPTION OF THE INVENTION

The invention will be described more fully in the following with reference to an embodiment example.

FIG. **1** is a longitudinal section through the front part of a hand-held screw driver according to the invention;

FIG. **2** is a cross section in plane II—II of FIG. **1** showing a view of an over-center mechanism of the hand-held screw driver according to FIG. **1**;

FIG. **3** shows a top view of a bistable spring element of the over-center mechanism according to FIG. **2**;

FIG. **4** shows a longitudinal section through the upper part of a torque coupling of the hand-held screw driver according to FIG. **1** in the locked-in position;

FIG. **5** shows a longitudinal section through the upper part of the torque coupling according to FIG. **4** in a dead center position; and

FIG. **6** shows a longitudinal section through the upper part of the torque coupling according to FIG. **4** in a separated position.

DETAILED DESCRIPTION OF THE INVENTION

FIG. **1** shows a longitudinal section through the front portion of an electrically powered hand-held screw driver **2**, e.g., a battery operated screw driver, with a housing **4**. A sleeve-shaped depth stop **6** is held in an adjustable manner at the front end of the housing **4** with reference to a work direction A of the hand-held screw driver **2**. This depth stop **6** encloses the front end of a tool spindle **8**, with reference to the work direction A, at which a tool bit **10** is fastened in a tool holder **11**. The tool bit **10** engages a fastener **12** in the form of a screw which is to be screwed into a receiving surface **14**.

The tool spindle **8** is operatively coupled by a torque coupling **16** with a drive shaft **18** that is driven by a motor **20**, shown schematically. For this purpose, the torque coupling **16** has a motor-side coupling part **22** which is held on the tool spindle **8** so as to be rotatable relative to the tool spindle and which is driven by the drive shaft **18**.

Further, the torque coupling **16** has a tool-side coupling part **24** which is held at the tool spindle **8** so as to be fixed with respect to rotation relative to the tool spindle **8** and with an axial movement play a relative to the tool spindle **8**. For this purpose, the tool-side coupling part **24** is guided in an axially displaceable manner and so as to be fixed with respect to rotation between a stop surface **26** produced by a reduced diameter and a securing ring **28** arranged at the tool spindle **8**.

For the purpose of transmitting torque between the two coupling parts **22**, **24**, the motor-side coupling part **22** has claw-shaped engagement means **30** which project in the direction of the tool-side coupling part **24**. Correspondingly claw-shaped counter-engagement means **32** which can be brought into engagement with the engagement means **30** of the motor-side coupling part **22** against the force of a coupling spring **34** are formed at the tool-side coupling part **24**.

The coupling spring **34** is formed by a frustum-shaped helical spring which contacts the motor-side coupling part **22** by its larger diameter and contacts the securing ring **28** by its smaller diameter. In this way, the tool spindle **8** is biased away from the motor-side coupling part **22** by the securing ring **28** by means of the coupling spring **34**.

An additional movement transmitter, shown particularly in FIG. **2**, is provided in the form of an over-center mechanism **36** separate from the coupling spring **34**. This over-center mechanism **36** has two bistable C-shaped spring elements **38** whose ends are fixed to bearing pins **40** that are fixed with respect to the housing as is shown especially in FIG. **3**. The two C-shaped spring elements **38** are formed from a wire and an adjusting portion **42** thereof engages in an annular groove **44** which is formed at the circumference of the tool-side coupling part **24**.

As can be seen from FIG. **3**, each of the two C-shaped spring elements **38** has a first rest position R**1** in which it forms a bend that is oriented opposite to the work direction A. The spring element **38** can be moved by external application of force into the dead center position T shown by a dash-dot axis. As soon as the C-shaped spring element **38** is moved a short distance beyond this dead center point, it automatically jumps into a second rest position R**2**, shown in a dash-double-dot axis, in which the C-shaped spring element **38** forms a bend in the work direction A.

The manner of operation of the C-shaped spring elements **38** during a screwing process is described more fully in the following with reference to FIGS. **4** to **6**.

Before the start of the screwing process, the hand-held screwing device **2** occupies the position shown in FIG. **1**. In this position, the two coupling part **22**, **24** are separated from one another by the coupling spring **34** to the extent that their engagement means **30** and counter-engagement means **32** are disengaged. The tool-side coupling part **24** is additionally pushed away from the motor-side coupling part **22** by the spring element **38** which occupies the second rest position. Consequently, no transmission of torque from the motor **20** to the tool spindle **8** via the drive shaft **28** is possible in this position.

FIG. **4** shows the upper half of the torque coupling **16** in a position at the start of the screwing process in which the fastener **12** is pressed against the surface **14** by means of the hand-held screw driver **2** by the user. The pressing pressure displaces the tool spindle **8** backward relative to the housing **4** opposite to the work direction A against spring force of coupling spring **34**. Together with the tool spindle **8**, the tool-side coupling part **24** is also displaced in direction of the motor-side coupling part **22** through contact at the stop surface **26** of the tool spindle **8** until the engagement means **30** engage with the counter-engagement means **32** as is shown.

In addition, the adjusting portion **42** of the spring element **38** is also moved with the tool-side coupling part **24** and is displaced from the first rest position R**1** beyond the dead center position T. Immediately after the dead center position T is passed, the over-center mechanism **36** automatically jumps into the second rest position R**2** and presses the tool-side coupling part **24** against the motor-side coupling part **22** by means of the adjusting portion **42**.

In this way, torque can now be safely transmitted from the motor **20**, via the drive shaft **18** and the torque coupling **16**, to the tool spindle **8**, the tool bit **10** and the fastener **12** arranged at the latter. As a result of this transmitted torque, the fastener **12** progressively penetrates into the surface **14** until the depth stop **6** contacts the latter.

When the depth stop **6** contacts the surface **14**, pressing pressure is no longer conveyed to the tool spindle **8**. Therefore, the latter moves farther in the work direction A away from the motor-side coupling part **22** only due to the biasing by the coupling spring **34**. The tool-side coupling part **24** is displaced relative to the tool spindle **8** within the limits of the axial movement play a and comes into contact with the securing ring **28** (FIG. **5**). As a result of this contact, not only the tool-side coupling part **24** together with the tool spindle **8**, but also the adjusting portion **42** of the spring element **38** is displaced from the rest position R**1** by the tool-side coupling part **24** by means of the coupling spring **34**.

FIG. **5** shows the position of the torque coupling **16** in which the dead center position T of the over-center mechanism **36** is traversed during this displacement of the adjusting portion **42**. At this point, there is a minimum engagement depth b between the engagement means **30** and the counter-engagement means **32**, so that torque is still transmitted between the drive shaft **18** and the tool spindle **8**.

As soon as the adjusting portion **42** has passed the dead center position T, the spring element **38** is released. As a result, the kinetic energy stored by the spring **38** in the first rest position R**1** is suddenly released so that the adjusting portion **42** jumps into the second rest position R**2** as is shown in FIG. **6**. During this movement of the adjusting portion **42**, the latter carries the tool-side coupling part **24** along with it and the latter is displaced in work direction A within the limits of the axial movement play a. The counter-engagement means **32** of the tool-side coupling part **24** is accordingly suddenly separated from the engagement means **30** of the motor-side coupling part **22**.

The sudden movement of the tool-side coupling part **24** relative to the motor-side coupling part **22** described above results in a separation of the torque coupling **16** with reduced noise and reduced friction and causes the transmission of torque to stop. In this way, greater user comfort and a longer life are achieved by the hand-held screwing device **2** according to the invention.

What is claimed is:

1. Electrically powered hand-held screw driver (**2**) comprising a housing (**4**) having an axially extending work direction (A) with a leading end and a trailing end for driving screw-type fastening elements in the work direction into a receiving material (**14**), said housing (**4**) carrying a drive motor (**20**), a tool spindle (**8**) axially displaceable in the work direction and operatively coupled to a tool holder (**11**), and a torque coupling (**16**) positioned between said drive motor (**20**) and said tool spindle (**8**) and having a motor-side coupling part (**22**) and a tool-side coupling part (**24**) connected to said tool spindle (**8**) and fixed with respect to rotation relative to said tool spindle (**8**), said coupling parts (**22**, **24**) engageable with one another and with said tool spindle (**8**) biased away from said motor-side coupling part (**22**) by a coupling spring (**34**), said tool-side coupling part (**24**) has axial movement play (a) relative to said tool spindle (**8**) and is mechanically coupled with a movement transmitter separate from said coupling spring (**34**).

2. Electrically powered hand-held screw driver, as set forth in claim **1** wherein said movement transmitter is formed by an over-center mechanism (**36**) comprising a first rest position (R**1**), a dead center position (T) and a second rest position (R**2**) which automatically jumps to the second rest position (R**2**) when movement from the first rest position exceeds the dead center position (T), and automatically jumps to the first rest position (R**1**) when movement from the second rest position (R**2**) exceeds the dead center position (T).

3. Electrically powered hand-held screw driver, as set forth in claim **2**, wherein said tool-side coupling part (**24**) remains engaged with the motor-side coupling part (**22**) in the dead center position (T) of the over-center mechanism (**36**).

4. Electrically powered hand-held screw driver, as set forth in claim **2**, wherein said over-center mechanism (**36**) has at least one bistable C-shaped spring element (**38**) having opposite ends fixed to said housing (**4**).

5. Electrically powered hand-held screw driver, as set forth in claim **4**, wherein said spring element (**38**) is formed of a wire.

6. Electrically powered hand-held screw driver, as set forth in claim **4**, wherein a securing ring (**28**) in fixedly clamped to said tool spindle (**8**) and forms a stop for said tool-side coupling part (**24**) in the direction toward said motor-side coupling (**22**) and said spring element (**38**) contacts said securing ring (**28**).

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